COAL MINING

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ANN ARBOR, MICH

May, 1958 Volume 35, No. 5

All I need to know about mining equipment...

Yes, like other leading operators, all I need to know about mining equipment is that it's *sold* and *serviced by Highway!* That's my guarantee that my work will start on time, continue steadily without interruption—and give me top profits.

AA-7191

Lima 2400 removing overburden for C & K Coal Co., near Parker, Pa.

Allis-Chalmers HD-21 spreading and compacting crushed stone in construction of haul road at Snyder Coal Co. strip job near Adrian, Pa. Tractor is also used for overburden removal and shelving.

25TH Anniversary HIGHWAY EQUIPMENT CO. 1933 · 1958

Highway

HIGHWAY EQUIPMENT COMPANY

6465 Hamilton Ave. · Pittsburgh 6, Pa.

Allis-Chalmers • Lima Shovels, Cranes, Draglines • Master General Motors Diesel Engines • Power-Pack Conveyors Gar Wood • Lima Roadpackers • Thor • Jaeger Michigan Tractor Shovels and Excavator-Cranes

Jaeger 6" Pump, with General Motors Diesel engine, solves water problem for C & K Coal Co. Water is pumped 45 ft. up cut and 120 ft. to point where it is expelled in gravity run area.

For the best in all types of mining equipment...

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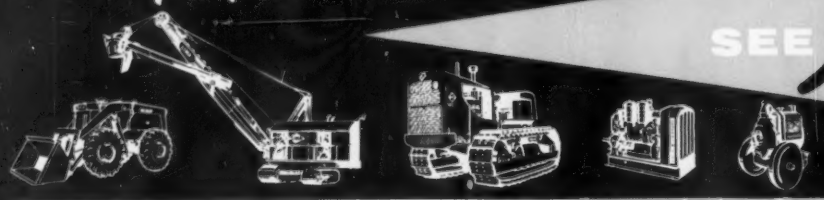

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use equipment from *Highway*

Allis-Chalmers HD-21 and Lima 2400 form profit-winning team for Snyder Coal Co., Cowansville.

For 25 years, Highway has specialized in helping coal operators obtain maximum production through use of the right equipment. And, besides selling the world's finest equipment, Highway has always backed each sale with its own guarantee and 'round the clock service.

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WITH *HEAVY — RUGGED — POWERFUL*

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MODEL 106-24

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Bores faster, deeper, larger dia. holes than any other auger drill. New gear reduction unit slows auger rotation for operation in hard rock formations. Drills 8" and 9" dia. holes readily in shale and sandstone formations, drills larger dia. holes up to 24" dia. in softer formations.

Write for Bulletin M-100

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Gives Desired Rotating Speed Of Auger

HYDRAULIC FEED

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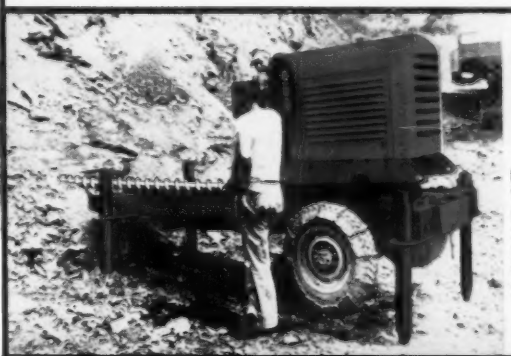
"Walks" from hole to hole to auger high-quality Bonus Coal

An Ohio miner removes 450 tons of coal in each 6 1/2-hour working day with this Model 14 36-42 x 12' McCarthy drill, operated by two men. He drills 42" dia. holes 144' deep. Auxiliary conveyor eliminates spillage at hole. It operates on either side of drill for working blind cut. Twelve different models of McCarthy Coal Recovery Drills mine low-cost "bonus coal."

Write for Bulletin M-101 and M-102



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SALEM

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STOCKPILING COAL for the William Aloe Coal Co., this 1¼-yd. shovel gets its power from a Cat D8800 Engine. A D13000 powers a 1½-yd. shovel, also stockpiling coal.

LOADING OUT COAL in the operation of the William Aloe Coal Co., this 2½-yd. shovel is powered by a Caterpillar D337 (Series F) Turbocharged Engine.

Standardize on CAT Diesel power for the tough mining jobs

A. J. Schmidt, Purchasing Agent of the William Aloe Coal Co. at Imperial, Pa., now relies on Caterpillar for 100% of his engine power requirements in coal loading operations

That's a sound move for *any* mine. When you're powered 100% with Cat Diesels, you're sure of dependable performance in *every* phase of your engine power requirements. Their reliability has been a by-word on punishing applications for more than 25 years, because they were built for the hard work. Today, as a result of constant development, these modern heavy-duty units are tougher and more efficient than ever.

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5. Is free from frequent checks and adjustments.

For complete information about Cat Engines and Electric Sets see one of Beckwith Machinery Company's Engine Specialists. He knows your power requirements and we back your purchase with fast, efficient service and high quality factory parts. For original or replacement power—for honestly rated, certified power—give us a call!

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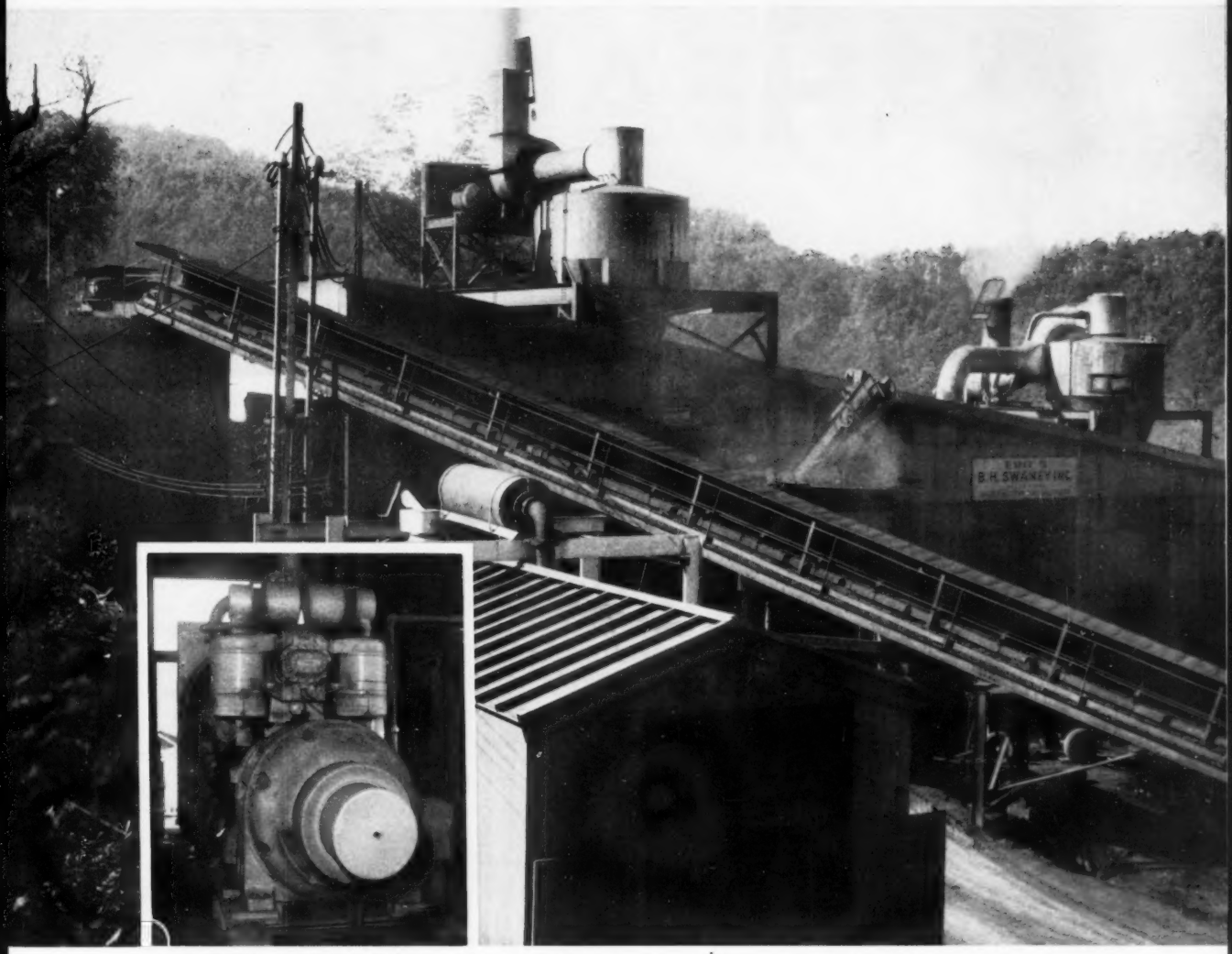
ENGINE POWER BY CATERPILLAR



FURNISHING POWER FOR THE ENTIRE TIPPLE, this Cat D397 Electric Set often starts Monday morning and doesn't shut down until Saturday night. Tipple consists of 2 crushers, 3 vibrators, 10 flight conveyors, furnace, air cleaner and washer. Production: 1,500 tons a day. Owner B. H. Swaney, Inc., Charlesburg, West Virginia.

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Send me more information about Caterpillar Diesel Engines. I have checked the proper box to guide your selection of material.

☐ I would like detailed information, as I may be in the market for a Cat Diesel Engine or Electric Set. I understand that I am under no obligation.

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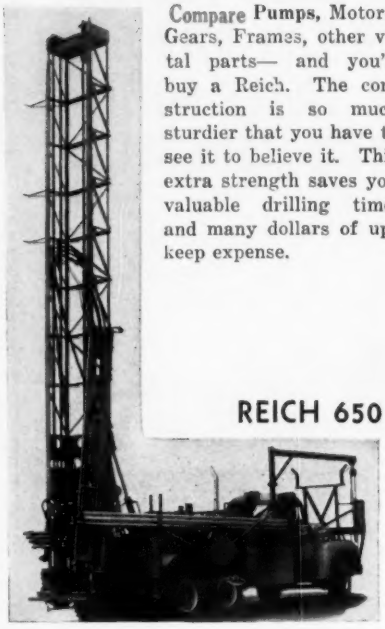

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Compare Pumps, Motors, Gears, Frames, other vital parts— and you'll buy a Reich. The construction is so much sturdier that you have to see it to believe it. This extra strength saves you valuable drilling time, and many dollars of upkeep expense.

You'll get results like these — *4 recent tests:*

- **52% more hole** per hour drilled in hard dense sandstone by Reich Drill than by other rotary drill of the same rated capacity.
- **80% more hole** drilled by Reich 650-H-25 in shale and medium sandstone, than by other hydraulic powered rotary of same rated capacity.
- **Weighing 6½ tons less** than a crawler rotary that cost almost twice as much— Reich 650 drilled 7⅜" holes approximately as fast in hard tough sandstone.
- **238 ft. per hour** in medium sandstone and shale drilled by Reich 750-H-45 Crawler in 3½-hour test, drilling 40 to 50 ft. holes— including all moves.

(Full details of the above cases — and many more — sent on request)

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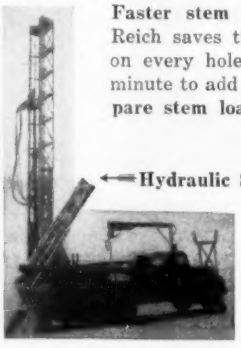
Exactly Right Drilling Speed in every material, from hardest to softest. The only hydraulic rotary with **infinitely variable drilling speed.**

Easiest operation with minimum of control levers and no "strong-arm" levers to slow the operator— all controls actuated by hydraulic power. **A real one-man drill rig.**



Faster stem loading of the Reich saves time and money on every hole. Less than a minute to add a stem. **Compare stem loading.**

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Find out the Extra Profit you'll make with a Reich Drill. Records made by these rigs are not secrets. Inquire of owners nearest you, what results they are getting— we'll tell you where they are. They have found the Reich the biggest producer, by far the most profitable drill rig you can own. Write, wire or phone—

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Adverse haul conditions reducing your output?

Put your hauling operation on a high-production basis — despite restricted areas, rough winding roads, or bad weather conditions — with rugged LeTourneau-Westinghouse Tournapull® Rear-Dumps. Here's how these pivot-steer haulers can cut minutes off your haul cycles.

Speeds loading — Because the Tournapull prime-mover pivots 90° right or left, you can place L-W Rear-Dumps under the shovel *quick*. Low, wide bowl-opening gives shovel operator big, easy target . . . cuts spillage. Production delay for clean-up of pit-floor is minimized. Three-layer, all-steel bowl floor withstands pounding of heavy rocks. Sloping sides deflect load shock, cushion floor area with layer of material.

Hauls anywhere — Equipped with exclusive power-transfer differential, L-W Rear-Dump keeps load moving steadily through mud and slippery footing, over uneven ground, and around sharp turns. Big, low-pressure tires give top flotation — low center of gravity assures stability on uneven terrain.

Dumps quick, clean — Flick of switch on control panel instantly activates point-of-action electric hoist-motor. Body raises quickly, to desired angle. At full-dump position, edge of bowl is low behind rear wheels. Material dumps clean. It cannot roll forward to lodge against wheels, nor pile under rear end. Streamlined body sheds stickiest material readily.

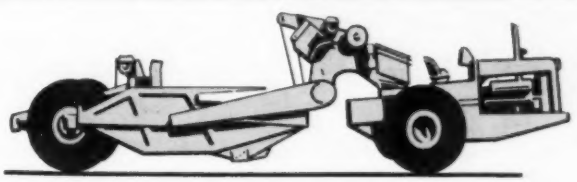
Safe, effortless control — Both dumping and steering are actuated by a quick, simple finger-tip movement on electric switches. Giant air brakes — combined with Electrotarder, for auxiliary non-wear fly-wheel brake power — add safety.

Maintenance is low, because highly-simplified L-W Rear-Dumps eliminate so many vulnerable parts that cause trouble on conventional haulers. All-welded, reinforced steel bowl resists toughest wear and shock.

Compare its performance

Let us demonstrate a haul-anywhere L-W Rear-Dump at your pit. Compare its time-saving performance against your present haulers. Select from 3 sizes: 11, 22, and 35 tons. Call or write for complete information.

R-1862-MQ-1



Converts to easy-loading scraper

When rock-hauling work is completed, you can interchange the L-W Rear-Dump trail-unit with an easy-loading scraper, behind the basic Tournapull prime-mover. You'll then have a double-duty tool for stripping and roadbuilding — or to rent out profitably for all types of earthmoving projects. Scraper is available for about ¼ the cost of complete original L-W Rear-Dump. Other specialized trail-units to increase prime-mover's usefulness also available.

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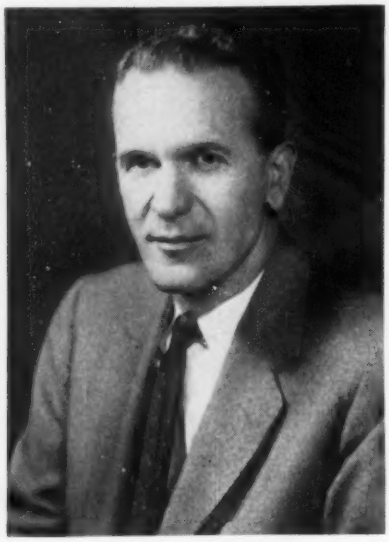

Louis A. DePolis,
Vice President — Marketing,
LeTourneau — Westinghouse Company,
Peoria, Illinois

William D. Lease
Board of Directors
Athey Products Corporation

● Louis A. DePolis has been named vice president in-charge-of marketing for LeTourneau-Westinghouse Company, according to an announcement from the firm's Peoria, Illinois headquarters by President Merle R. Yontz. The appointment becomes effective immediately.

DePolis comes to LeT-WesCo from the Industrial Truck Division of Clark Equipment Company where he had served as director of sales since 1953.

In his new position, DePolis will not only direct the LeT-WesCo sales organization, but also supervise and coordinate all marketing and marketing related activities including those of sales promotion, advertising, equipment service and field engineering.

President Yontz points out that DePolis has had extensive experience and an outstanding record of success in the heavy equipment sales field.

* * * * *

● WILLIAM D. LEASE was elected to the Board of Directors of ATHEY PRODUCTS CORPORATION at the Annual Shareholders' Meeting on April 2, 1958. At the Annual Directors' Meeting, held on the same date, Mr. Lease was elected Executive Vice President of the Corporation.

In his position as Vice President of Sales, to which he was named in 1954, Mr. Lease was in charge of the company's sales efforts throughout the world. Prior to his activities in the Sales Department, Mr. Lease held positions in the various departments as Plant Engineer and Manager of Research and Development.

Mr. Lease has an engineering degree from Illinois Institute of Technology and served in the U. S. Navy from 1943 to 1946. He became associated with Athey in 1946.

Mr. Lease, his wife and three sons make their home in Western Springs, Illinois. Hobbies: Golf and traveling the world over locating new areas and uses for trailers wearing yellow paint.

● Coalorerok Machinery Agency, 429 South 24th Street, Birmingham, Alabama, has been appointed as representative in Alabama for the LONG Company, Oak Hill, W. Va., manufacturers of mining machinery and conveying equipment.

The announcement was made by R. C. Nelson, vice president of LONG, who stated that Coalorerok will handle all sales and service of LONG products in Alabama.

The Coalorerok organization is headed by J. L. Thomas, who has had many years experience in the coal mining industry. He was with Jeffrey for more than 20 years, and, prior to his present affiliation, was employed by National Mine Service Company.

● Shenango Furnace Company of Pittsburgh has purchased the Lucerne Coke Company at Indiana, Pa., from the Rochester and Pittsburgh Coal Company.

The purchase price was not disclosed. President W. P. Snyder, III, of Shenango Furnace Company, who also will head the newly acquired firm as its president, said Lucerne Coke will be operated in the future as a wholly-owned subsidiary.

Lucerne Coke Company operates 264 beehivee coke ovens. These ovens, built in 1952, are the newest beehive coke ovens in the United States. Part of Lucerne Coke's future production will be used in Shenango Furnace Company's own blast furnaces at Sharpesville, Pa., and the remainder sold to coke consumers in the Pittsburgh district.

COAL MINING

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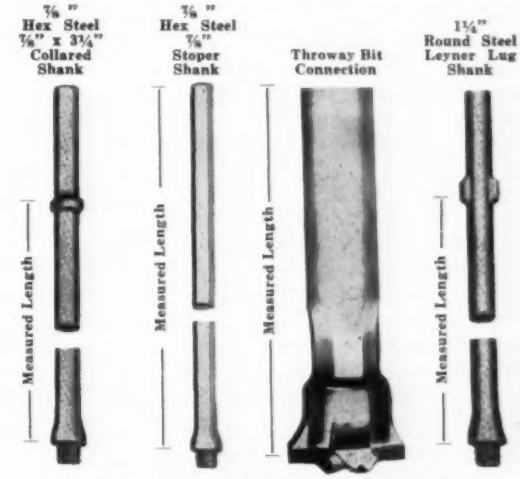

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Do You Know?

The flashing of the two Russian satellites in the skies has had a tremendous influence on the public's view of science and technology. Perhaps the prestige of scientists and engineers will rise. If not too much is expected of them toward solving the immediate crises in world affairs (which means first of all preventing atomic war), all may be well.

It should be pointed out that no matter what is done about science education, reinforcing basic or pure research, getting more youths to become scientists, paying teachers more, etc., all will be lost if the H-bombs are let fall with a figurative button-push. Peace, armed though it be, is the first requirement.

Assuming that peace will continue, there is good reason to consider a thousand and one plans for improving science, technology and education. Congress will have hundreds of bills on education and science introduced when it convenes. More millions, not large when compared with three major defense funds, will be appropriated.

These things seem appropriate:

Encourage boys and girls to experiment in science and reach out and find many more at the earliest possible ages who have the abilities to be scientists of the future.

Upgrade and encourage our teachers of science. This means more pay, more appreciation and more help like the summer institutes for science teachers funded by Congress through the National Science Foundation.

Give more support to colleges and universities so that they can, through their institutionally administered scholarships, assure that everyone capable does have a chance to go to college. This does not necessarily mean a big federal scholarship program and any science academy run like West Point or Annapolis would be inadequate.

● James D. Francis, chairman of the board of The Powellton Coal Co., and former head of Island Creek Coal Co., died in Huntington, W. Va., on Jan. 8. Death came unexpectedly from a heart attack during his recovery from an accidental fall in which he suffered a broken leg several days earlier. Funeral services were held at the First Presbyterian Church of Huntington, with interment in Woodmere Cemetery.

HERE AND THERE IN THE COAL INDUSTRY

Henri Pell Junod

● One of Cleveland's leading coal, iron and docking industry executives, Henri Pell Junod, a partner in the firm of Pickands Mather and Co., president and director of the Hamilton Supply Co., Marquette Dock Co., Portage Coal and Dock Co., vice president of the Olga Coal Company and a director of six other iron ore docking companies, has been appointed a group chairman in Division A of Greater Cleveland's first United Appeal. He has been a Community Chest volunteer serving with Division A since 1943.

The six Division A group chairmen are responsible for appointing the captains of the 31 division teams, 26 of whom solicit gifts from business and industry, five from the professions, estates and individual women. Group chairmen also assist and instruct the captains. The trade teams, ranging in size from 12 to 175 members, solicit both corporate and executive gifts.

Division A, the biggest of all United Appeal divisions, is expected to be asked to raise about 70 percent of this years' goal. The Appeal will join the fund-raising drive of the Community Chest with that of the Greater Cleveland Chapter of the American National Red Cross.

● Walker Kennedy, president of Liberty Fuel Co., was elected president of the Utah-Wyoming Coal Operators Association at the annual meeting April 2 in Salt Lake City. He succeeds W. J. O'Connor, president and general manager of Independent Coal and Coke Co. G. E. Sorensen, president of the The Kemmerer Coal Co., Frontier, Wyo., was elected vice president and the following were reappointed for another term: T. J. Canavan, executive secretary and treasurer; D. A. James (vice president of Liberty Fuel Co.) assistant treasurer; and Mrs. Clara Outsen, assistant secretary. Directors reelected, in addition to Messrs. Kennedy, O'Connor and Sorensen, include A. B. Foulger, vice president and general manager, Lion Coal Corp.; Oscar A. Glaeser, president, United States Fuel Co,, and P. L. Shields, president, Spring Canyon and Royal Coal Companies. W. W. Clyde, president of Knight Ideal Coal Co., which recently became a member of the Association, also will serve as a director.

● Glenn E. Sorensen, president of Kemmerer Coal Co. at Kemmerer, Wyo., has been elected president of the Wyoming Mining Association. Mr. Sorensen has been an active member of the Association, whose membership represents diversified mining interests. Myron L. Sisson, of Colorado Fuel and Iron Corp., was elected vice president. R. W. Beamer was reelected executive secretary, at Riverton, Wyo. A statement of policy adopted by the Association on April 18 cites the coal deposits in Wyoming as one of the State's most valuable resources and urges establishment of a Federal coal research program. It also recommends amendment of the Mineral Leasing Act to increase from 5,120 acres to 10,240 acres the coal land which may be held in any one State by one person, association, or corporation.

Evolution and Growth of
Continuous Coal Mining Systems

By P. R. PAULICK
Consulting Mining Engineer — Bethel Park, Penna. — U. S. A.

Intense intra-industry competition, together with a three-pronged progressive squeeze from gas, oil, and high wages, dictates the urgency of developing high capacity coal production machines, together with simple and efficient mining systems so as to produce maximum tonnages at minimum cost. In the United States the answer is the "Continuous Miner" working in a "one place" mining system.

Continuous miners in the United States are of two basic designs; the "ripper" type and the "borer" type. Each has its place and function in our varied coal seams, mining conditions, and economy. Moreover, because our natural mining conditions are such that the conventional room and pillar system of mining predominates, all the present continuous miners are mobile and self propelled.

Because of this mobility, we have been able to design and develop production units, as well as the mining systems, that are radically different and as a matter of fact simpler than the mining systems used with conventional mechanical loaders, or even hand loaders.

Another advancement and indeed a great help has been the development of an "extensible" belt permitting the mining and driving continuously of "long rooms" — up to 1000'. Formerly the standard room depth always seemed to be the magical 300' room. This was true with hand loading, convevor mining, and all forms of mechanical mining track and trackless systems. As a matter of fact, even with the advent of the first continuous miners, the mining system still seemed to revolve around the 300' room. However, since the introduction and general adaptation of the extensible belt conveyor, we are planning and developing mining systems with rooms up to 1000' deep. The utilization of a combination of long rooms, and one room mining system has permitted us to produce maximum tonnage from a minimum number of places — one, — thus attaining minimum production cost.

Following is a brief outline of how the transitional development from old time hand loading methods to present continuous mining systems evolved.

FIGURE #1. Shows a typical hand loading section or mining system in a typical hand loading coal mine prior to 1923 period. That is to say, premechanical loading period. Of course, many variations of mining methods for hand loading existed then, just as there are many variations of mining methods used with conventional mechanical loaders, as well as with continuous miners today. But for illustration, Figure #1 shows a good average hand loading operation.

By 1923 many experiments with mechanical loaders were being conducted, and several units were placed in actual operation. Moreover, the percentage of coal undercut by machines, at that time considered mechanization, had risen to 68.3% of total produced. During this pre-1923 period a hand loading section generally consisted of 18 to 20 rooms with two hand loaders per room.

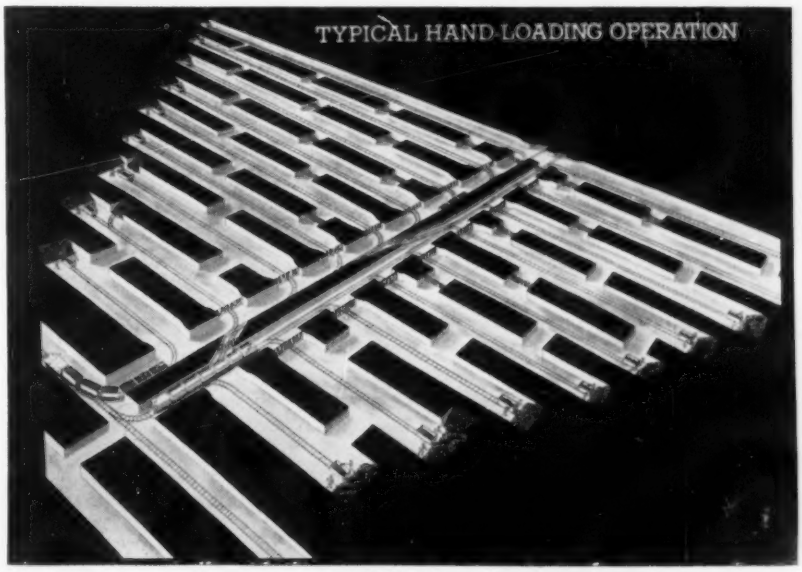

FIG. 1

These men did all the work necessary to produce the coal: lay track, timber, drill and shoot coal, and load it into mine cars which they pushed from entry switch to working face themselves.

A typical labor force in such a section consisted of 36 hand loaders, 2 transportation men, 2 cutters, and one trackman. A total of 41. As a rule one foreman had 2 such sections to supervise. Total average production from such a section amounted to 360 tons, or 8.8 tons per man-day, not including foreman. The overall industry-wide productivity amounted to 4.47 tons per man-day at that time.

By the end of 1923 some mechanical loaders had been installed and established to the point that 0.3% of total underground production was mechanically loaded and recorded.

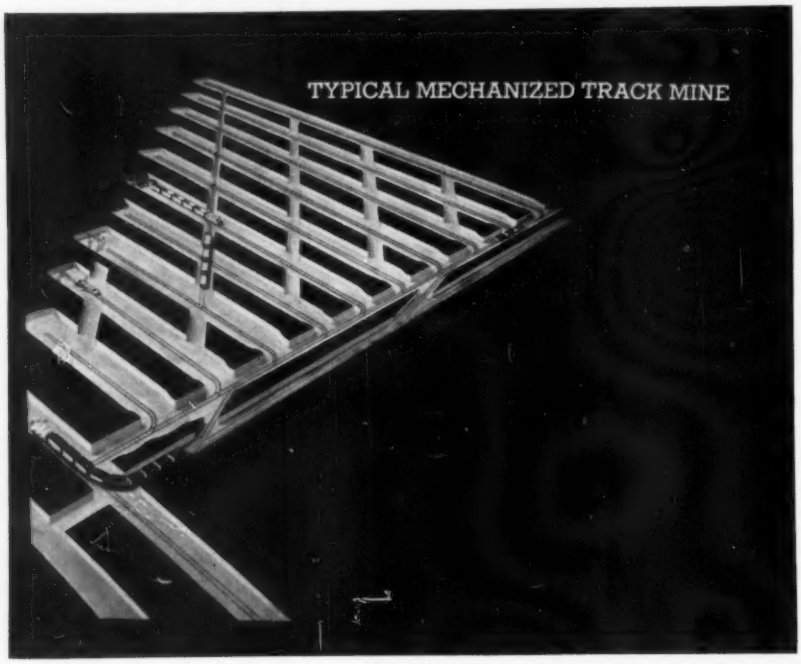

FIG. 2

FIGURE #2. The board period 1923 to 1936, was one of intense activity in all forms of mechanization, not only loading, but cutting and drilling of coal. Coal cut by machines had increased to 84.8% of total underground production, and coal loaded mechanically increased to 16.3% of total. This period was characterized by the fact that up to now all types of mechanical loaders, track and caterpiller mounted, loaded coal directly into mine cars, usually small ones at that. During this period the significant transportation development was the increase in mine car capacity from 1 ton up to 10 tons. Today many mines still using conventional mechanical loading methods use cars of 15 and some up to 20 ton capacity.

Generally speaking, a typical track mechanical loading section consisting of 10 to 12 places, with track in each place, hence necessitating laying switches in all breakthroughs, etc. A typical labor force consisted of 16-18 men per section. A good average production amounted to 360 tons per shift, or 22.5 tons per sectional man-day. Of course, here again many variations of this system were used and practised by the many coal operators. The total overall industry-wide miner productivity had now risen to 4.62 tons per man-day.

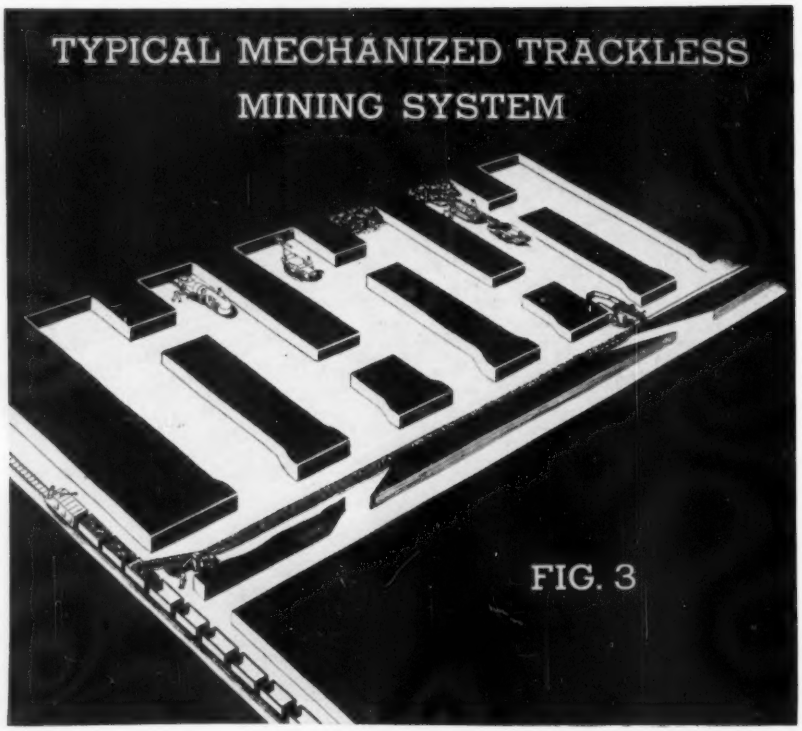

FIGURE #3. By now many coal operators and several machinery manufacturers began to look around and experiment with various improved methods of taking coal away from the mechanical loader. Too much time was consumed by the "change car" item of the track-type operation. Moreover, the labor needed to lay track and recover track after a section was completed was considered too high. Many experi-

ments and systems were tried and developed during this period: loading directly into chain conveyors, shakers, rubber tired shuttle cars were developed, etc. At any rate, the the period 1936 to 1948 was characterized by the development and operation of "trackless" mining systems.

FIGURE #3 shows a typical trackless mining system wherein all track has been removed not only from the producing rooms, but entries as well. Transportation of coal in rooms is by rubber-tired shuttle cars which unload onto a rubber belt laid in the panel entry. Some mining systems, however, still exist where mine cars are used in panel entries. Many modern mines today are planned and laid out all "trackless": the so-called belt mines wherein all transportation from room neck to tipple is by belt transportation.

The average number of places used with trackless mining is about 5-6. A labor crew of 10-12 is used to produce an average of 360 tons of coal per shift, or 36.0 tons per man-day. The overall industry-wide miner productivity had now increased to 6.26 tons per man-day. Moreover, the total coal undercut by machine has now risen to 90.7%, and coal loaded mechanically to 64.3%.

By 1948 all phases of coal production: cutting, drilling, transportation, loading, and even timbering, were highly mechanized. However the ceaseless, constantly increasing pressure from competing energy fuels, namely oil and gas, plus high wages and intra-industry competition, dictated continued and increased search for further cost cutting methods. The present "Continuous Miner" together with "One Room" mining system appears to be our answer, at least for the time being. There is no doubt that even more productive machinery and improved mining methods or system will be developed in the future. Automation in coal mining is the next by big forward step in the fight to reduce and maintain low unit costs.

Four typical mining systems using continuous miners are described. Again I wish to repeat, that while these four systems are typical, they are by no means the only ones used.

There are many others, but these four represent typical illustrations of the best methods developed so far. These can be used with either the "ripper" or "borer" type continuous miner.

FIGURE #4 Typical Block Mining System

Like all mining systems described so far, the block system of mining has many variations as to size of block room centers, room and entry width, etc. These variations depend upon many diverse factors such as depth of cover, roof conditions, type of equipment used, percent extraction desired, etc. With some systems the whole block is recovered by successive "cuts" or "slices", while others only "split" the block both ways as shown in illustration.

While details do vary, the basic system itself consist simply of driving a series of rooms, or entries, usually 7 or more abreast. With continuous miners the places are driven 16' wide on 80' centers, with breakthroughs every 80' so that we have a solid block of coal 64' square. The depth of these places depends upon company mining plans and varies from 1000, 1500, to 2000' deep.

After the places are driven to the desired distance, the blocks are then recovered on retreat by splitting two ways as shown in illustration. This results in about 65% recovery.

Like the mining system itself, the actual loading of coal may vary. Some companies "rip" the coal off the face and drop it on floor which acts as a reservoir or bin, and keep

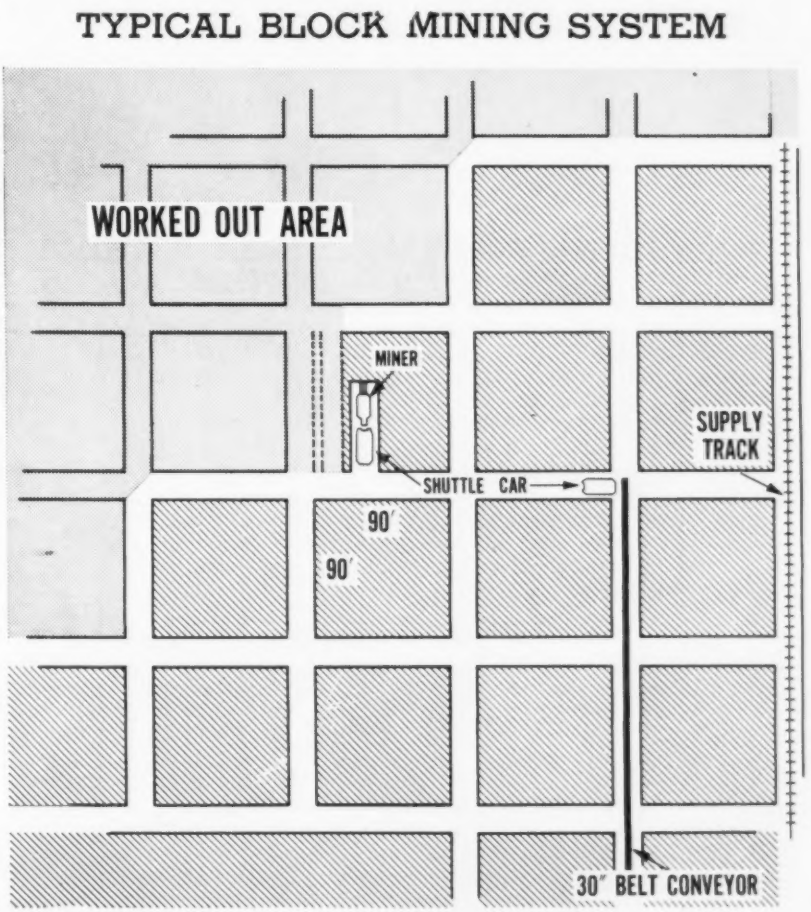

FIG. 4

on "ripping." The coal is then picked up by a conventional loader and loaded into rubber-tired shuttle cars to be hauled to a belt and surface. Other companies use one shuttle car behind the miner as a surge bin or reservoir, which in turn unloads into a second shuttle car for transportation to belt and outside. While these units have attained 500 to 600 tons on a good day, the figures used here are monthly averages. On this basis the block system produces an average of 345 tons with a crew of 6 men including a full-time mechanic, or 57.5 tons per face man-day.

FIGURE #5. Typical Long Room System-No Pillar Recovery

Prior to the introduction of continuous miners and development of extensible belts, the standard mining system for hand, mechanical, or even continuous miners, utilizied the so-called 300' room. Since the advent of extensible belts, the length of rooms has increased so that now we have mining systems using 600' and even 1000' rooms.

Moreover, a new mining system known as "punch" mining and has been developed and used at strip operations when the "high wall" gets too high for the strip shovel. A continuous miner equipped with an extensible belt is used to punch or drive a systematic series of holes or rooms in the high walls. While differing slightly from the true underground version, it nevertheless utilizes the same principle: driving a long room in a straight line with periodic breakthroughs for ventilation to a depth of from 600 to 1000'. After a room is driven the desired distance, another room is driven parallel to the last, leaving a 6 to 10' pillar as desired.

With the punch mining system very good coal recovery and tonnage per machine are attained. For example, one such unit produced an average of 374 tons of coal during one month operation. This with a crew of 6 men, averaging 62.3 tons per man-day. Moreover, the unit produced 500 to 600 tons an individual one-day operation. The record was 625 tons in one shift with 6 man crew.

Figure #5 shows a similar underground mining systems where 4 units are combined to make one section. The actual operation of the system is to drive 3 entries abreast 14' wide on 40' centers to depth of 1500'. A 36' belt is carried in the center entry during advance phase. After the entries are driven up the desired distance, the room coal is recovered on retreat by driving 2 rooms on each side with a continuous miner and extensible belt in each room. Rooms are driven in 600'. No pillars are recovered. Rooms are driven 16' on 32' centers with breakthroughs turned on 80' centers. After a room is driven full depth all equipment is moved into the next succeeding room and so on until all coal is mined in that particular entry.

The average crew in the set-up amounts to 5 men per room, or 20 men for the four units.

A good monthly average produc-

TYPICAL LONG ROOM SYSTEM—NO PILLAR RECOVERY

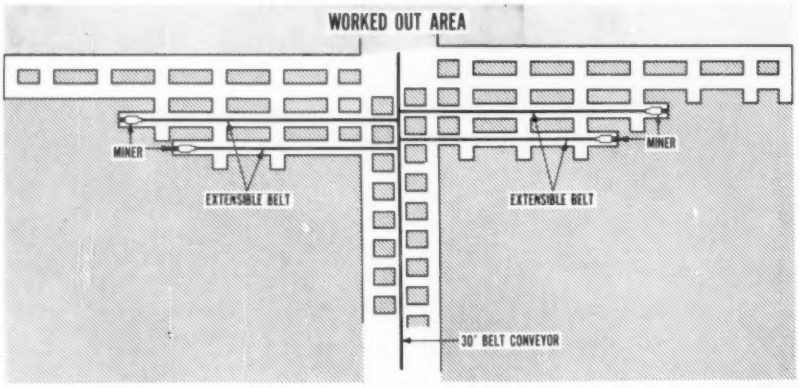

FIG. 5

TYPICAL HALF-ADVANCE, HALF RETREAT ROOM MINING SYSTEM

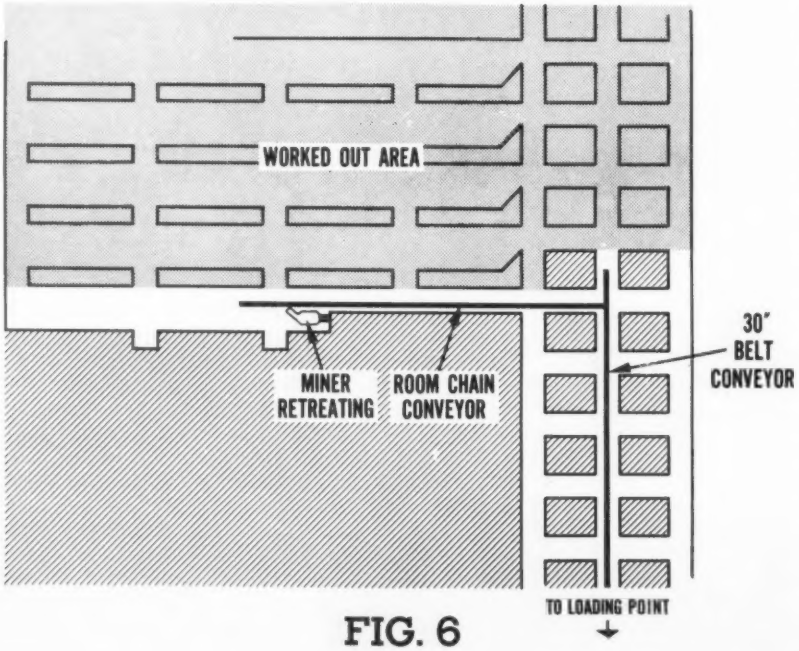

FIG. 6

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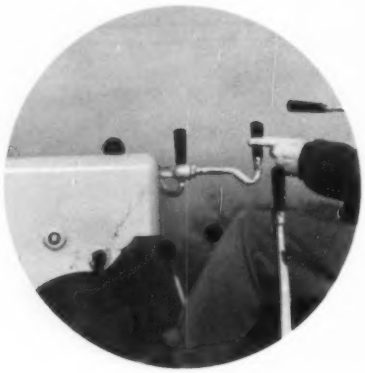

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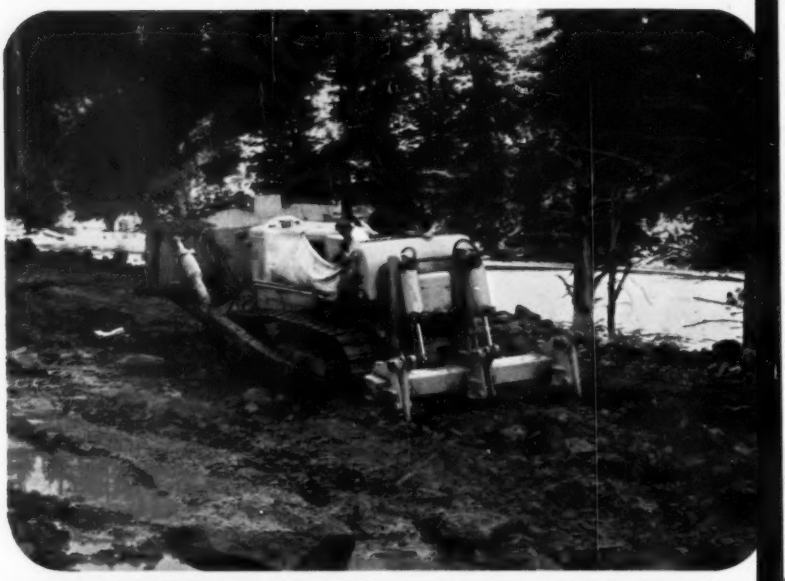

D9 *Money-making power*—here's the secret of the Cat D9 Tractor's success . . . the reason why contractors pick it for the tough jobs! For here's nearly 30 tons of money-making *power*—320 *honest* working *horsepower*—up to 98,000 lb. of push-pull power at 0.5 MPH (with adequate weight and traction)—7006 sq. in. of track on the ground for maximum flotation and traction.

Big? Sure—but the D9 handles so easily that operators compete for it. Here's why: controls are easy to reach and operate. Power-boosted brakes and steering clutches keep the operator producing at maximum efficiency. Easy operating, constant-mesh transmission and convenient forward-reverse lever provide fast changes in speed and direction.

The D9 is balanced whether push loading or handling a Cat-built Bulldozer, Scraper or Ripper. The same ease of control is designed into matched equipment. It's this controlled brute strength that makes the D9 outproduce and outperform all other makes. Ask your Caterpillar Dealer to give you the complete D9 story, and top it off with a demonstration.

CONTROLLED POWER for ripping in the roughest, toughest materials

D9 and No. 9 Ripper extend ripper speed and economy into more materials formerly requiring drilling and blasting. This excavating-ripping team cuts costs, speeds production on scraper loading and dozing. The No. 9 Ripper becomes an integral part of the D9 . . . ripper or dozer can be handled independently. Shanks are high-strength, heat-treated steel for long life. Shank design gives maximum penetration and easy pulling. Points are easily replaceable. Weight of tractor, design of point and shank, and hydraulic down pressure make the ripper penetrate quickly even in hard, rocky material. By actual tests, the D9 and No. 9 Ripper have cut production costs more than 80% as compared to drilling and blasting.

CONTROLLED POWER for big scale earthmoving at lowest cost

Power and the right application of that power are what it takes to move dirt – fast! Use the D9 as a pusher, and you'll see scrapers loaded faster and fuller than ever before possible. Or team it up with a Cat No. 491 Scraper for big scale earthmoving. The 34 cu. yd. (heaped) No. 491 is designed for easy-loading –often self-loading–and built for the roughest jobs. Job proven bowl design and placement of cutting edge make the material "boil" with less lifting–enable the No. 491 to get a heaped load quickly and easily.

High apron lift and positive dozer-type forced ejection clean the bowl completely and spread uniformly. Cat-built Cable Control gives positive, fast, controlled operation.

CONTROLLED POWER for big capacity earthmoving and clearing

Three kinds of bulldozers are built by Caterpillar for the D9 –angling, straight and U-type. They are engineered to dig and roll a full load and give the operator unrestricted visibility. Special-purpose Balderson Blades are also available for handling bulky materials.

Cat-built controls for the D9 include single and double drum cable control units, direct engine-driven for constant power independent of flywheel clutch or torque converter. For tilting the No. 9S Bulldozer, a Cat Tilt Cylinder is available, operated by a No. 50, No. 48, or No. 44 Hydraulic Control.

look to the dealer behind the product

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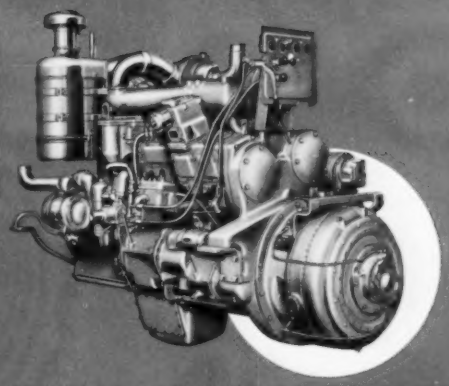
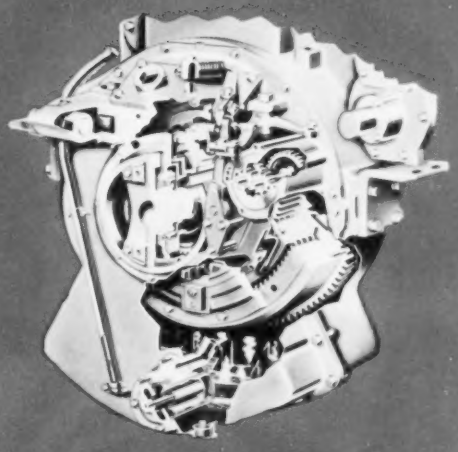
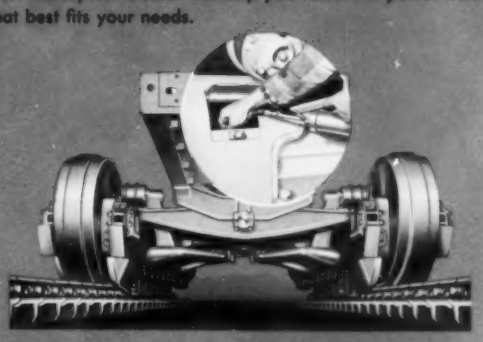
D9 BIG POWER BRUTE STRENGTH



World's mightiest crawler tractor engine powers the D9. It is designed specifically for the D9—turbocharged for maximum power output and efficiency, built for long life under the toughest operating conditions.



The D9 offers you a choice of three-stage torque converter with 5:1 torque ratio design and three speeds forward, two reverse — or direct-drive transmission with exclusive Caterpillar oil clutch and six forward and six reverse speeds. Your Caterpillar Dealer will help you select the power train that best fits your needs.



D9 track assembly is engineered for economical operation and minimum attention. Long life features include seven-roller track frames, cast steel diagonal braces, extra-strong strutless-design links, "Hi-Electro" hardened rails and pins. Convenience features include "500 Service Hour" rollers that allow longer service lubrication periods and hydraulic track tension adjustments that can easily be made by a hand-operated grease gun.

Your CATERPILLAR Dealer
has more
MONEY-MAKING EQUIPMENT
for the D9

Take full advantage of the controlled power in the D9 by teaming it up with the right equipment. Your Caterpillar Dealer will gladly help analyze your requirements and recommend the equipment that will do the job most efficiently.

He has a full line of Cat-built attachments, plus matched equipment such as rakes, stumpers, winches, back rippers, tree cutters, special U-Dozers, as well as heavy-duty trailers to transport the D9. He is headquarters for such respected products as Hyster Winches and Grid Rollers, Fleco Land Clearing Equipment, Rome Disk Plowing Harrows and Clearing Blades, and Preco Back Rippers.

Equally important, he carries an ample stock of original Cat parts—as well as parts for all matched equipment. He has the specialized tools and facilities to service your equipment quickly and at moderate cost. His factory-trained servicemen will help you get the most from your equipment investment.

Get to know your Caterpillar Dealer whose name is shown below. He's a good man to have on your team. Think of this, too—wherever your work takes you—in your community—or almost any place in the world, there's a Caterpillar Dealer nearby. See your dealer today!

(Above) D9 and Fleco M-A Rake clear and stack.
(Below) D9 and Rome K/G Blade cut and windrow.

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tion for the 4 units amounted to 920 tons per day, or 46.0 tons per face man-day.

FIGURE #6 Typical Half-Advance Half-Retreat Room Mining System

Just recently, a new and novel mining system has been developed for continuous miner operation which is attaining phenomenal results productionwise. The system consists essentially of driving a 16' room with a continuous miner to a depth of 350' and loading coal directly onto a 15" chain conveyor laid off center. Actually the depth of room is limited only by the ability of the chain conveyor. After the room is driven up the desired distance, a slab 12' wide is taken on retreat, again loading into the same chain conveyor which is recovered as the room retreats.

Rooms are thus driven 28' wide on 40' centers. No attempt is made to recover pillars. The rooms themselves are driven and completed advancing with the entry on one side, and retreating on the other side after the entry has been developed to the desired distance — usually 1200 to 1500'.

The average face labor crew with this system consists of 4 men who do all the work necessary to produce coal. Average daily production for one month period was 340 tons or 85.0 tons per man-day. This seems fantastic, but true. On record days some crews have loaded as high as 400 tons — averaging 100 tons per face man-day.

FIGURE #7. Narrow Rooms-wide Pillar Continuous Mining System

The narrow rooms with wide pillar continuous mining system is one of the latest methods developed strictly for continuous miner operation. Essentially the system consists of driving 3 panel entries to any desired limit 1200-1500-or 2000' or more. After a panel entry is driven to desired depth, rooms are worked on one side of the panel only. With this system pillars can be recovered or left in as desired simply leaving larger "fenders." Figure #7 illustrates pillar recovery method wherein 85% recovery is attained.

As stated, after a panel entry is driven to its planned depth, coal is recovered or mined on one side only—retreating. Two rooms 12' wide on 18' centers are driven up 500 or 600' as desired or planned. Each set of two rooms is separated by a 70 or 80' pillar of coal. When the narrow rooms are driven up the planned depth, the wide pillar is recovered by slabbing or "slicing" operation leaving a 5' fender between each slice which is also pierced in several places on retreat. The whole pillar is recovered in this fashion — by successive slicing on a 45 degree angle.

Where no pillars are recovered, the fenders are simply enlarged to 10' or whatever is needed to support the overburden.

With this system successive monthly averages of 624 tons per shift are attained, with a crew of 7 men, or 89.1 tons per face man-day.

FIGURE #8. Performance Chart

To show graphically the overall effect on total worker productivity since adoption and application of the highly efficient and productive continuous miners together with simple and effective mining systems, I have charted the overall industry-wide output of the American miner. This is shown in tons-per-man-day. The tons-per-man-day figures shown in this case includes all mine workers underground, surface, engineering, clerical and supervisory.

Prior to 1900 the tons per man-day fluctuated under 3.0 tons. By the year 1900 24.9% of coal produced underground was undercut by machines, a form of mechanization actually, and that year the miner productivity was 2.98 tons per man-day.

From 1900 to 1923 mechanization in the form of undercut coal had arisen to 68.3% of total and mechanically loaded to 0.3% of total, and overall miner productivity to 4.47 tons per man-day.

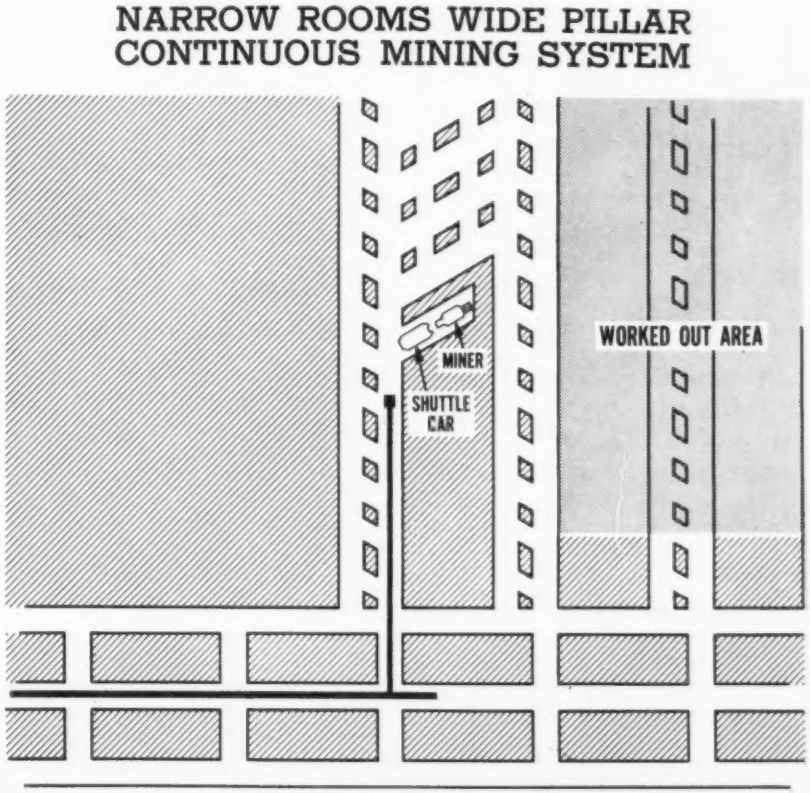


FIG. 7

By 1936 the percentage of coal undercut with machine had risen to 84.8%, and coal produced by mechanical loaders, mostly trackmouned, to 16.3% of total. Overall miner productivity rose to 4.62 tons per man-day.

Between 1936 and 1948, because of intense competition, strenuous efforts were made in all phases of mechanical mining to improve productivity. During this phase the rubber-tired shuttle cars were introduced and "trackless" mining systems developed. By 1948 the mechanically undercut coal percentage rose to 90.7% of total, and mechanically loaded coal to 64.3% of total. Overall miner productivity also attained a new high of 6.26 tons per man-day.

By now a new method of producing coal was introduced, the continuous miner method that eliminated all previous face cycle operations: cutting, drilling and shooting, only the loading phase remained. The new machines simply ripped or gouged the coal from the solid and loaded it into rubber tired shuttle cars, chain conveyors, and most recently extensible belts.

By the end of 1956 total coal undercut rose to 95%, while coal loaded mechanically rose to 85.4% of total. No separate figures are yet available as to percentage of coal loaded with continuous miners. Production from these units is now included in total mechanically loaded coal. Overall miner productivity rose to new high of 10.79 tons per man-day.

In conclusion allow me to give you a brief summary of pertinent statistics at what is happening to the overall industry-wide mine worker productivity since the introduction of continuous miners.

Year	No. Continuous Miners	Overall Tons Per Man-Day
1948	?	6.26
1950	?	7.04
1952	152	7.47
1954	320	9.47
1955	429	10.32
1956	583	10.79
1957		

Here you have irrefutable evidence that continuous miners are contributing in a big way to keeping the U. S. coal industry competitive with other forms of energy fuels: gas and oil. The price of coal has remained relatively stable even though miner wages have increased sharply. The coal industry now feels confident that it won't be long until the competitive position of coal will be stabilized to the point where coal will hold its own and even replace gas and oil, especially in the power producing industry.

COAL PRODUCTION 1900—PRESENT

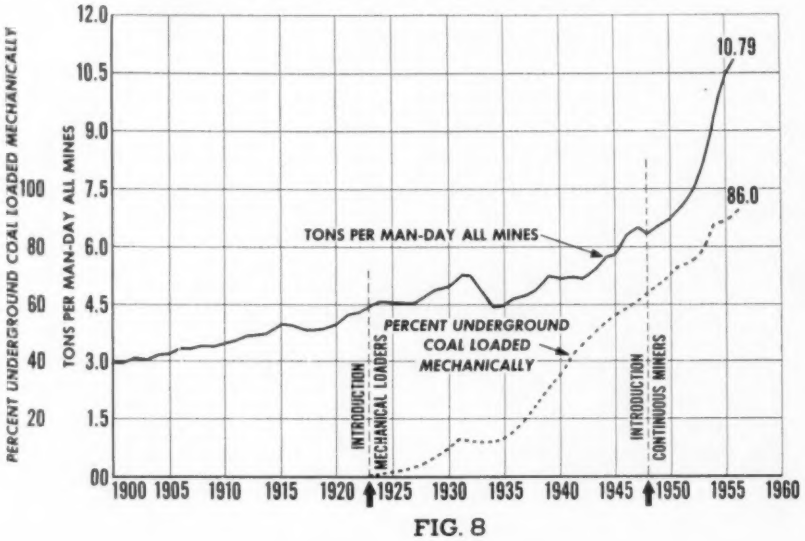


FIG. 8

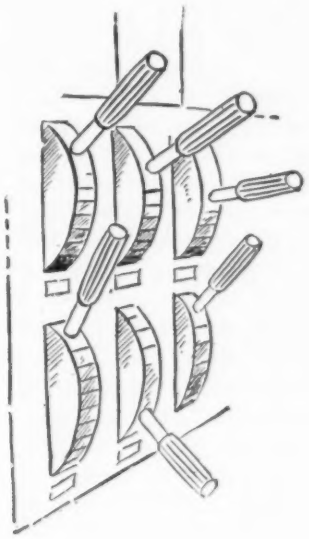
TABLE No. 1

Showing Salient Economic and Performance Data Corresponding to Illustrations or Slides Used in Paper.

Pertinent Data	#1	2#	#3	#4	#5	#6	#7
1. Period	Pre-1923	1923-1936	1936-1948	1948-1956	1956	1956	1956
2. Type loading	Hand	Mech. Tr	Mech. Trackless	Cont. Mng.	Cont. Mng.	Cont. Mng.	Cont. Mng.
3. Number places worked	18	12	6	1	1	1	1
4. Average No. men used	41	16	10	6	6	4	7
5. Average tons produced	360	360	360	345	374	340	624
6. Tons per man-day	8.8	22.5	36.0	57.5	62.3	85.0	89.1
7. Industrywide labor productivity	3.0-4.5	4.5-5.3	5.3-6.4	6.4-10.8	10.8	10.8	10.8
8. % coal produced Mech. underground	0	16	64	86	86	86	86
9. No. Mobile units working	0	1243	3980	4666	4666	4666	4666
10. No. Continuous miners working	0	0	0	583	583	583	583
11. % of underground coal produced with continuous miners	0	0	0	10	10	10	10

FIGURE No. 8 shows industryside mine labor productivity from 1900 to 1956.

Getting Full Rated Horsepower From Your Equipment



New electrical installations, or additions thereto, are expensive and ofttimes the equipment is not available on the market. It is, therefore, wise to study the electrical installation to determine if one is getting all one is paying for in the form of electrical bills. In many cases motors may be discovered to be running under-loaded or the Power Factor is at such a low value as to cause excessive penalties to be imposed by the Power Company.

THE FACTS ABOUT POWER FACTOR

We can learn all we need to know about power factor by three simple means — The analogy method, the semi-technical or mechanical, and the strictly technical. Unity power factor is the dream of the engineer but rarely realized with the exception of those installations using only electrical heating devices or perhaps those who have purely a lighting load. At 50% power factor for instance we have a case much like that of the merchant who must by force of circumstances permit half of his sales to be made at cost. He has the fully stocked store, the sales force and the modern cash registers to record his daily volume of business. Still he is immeasurably handicapped by the bugaboo of having 50% of his sales being made at a loss.

The plant operator with a high inductive load (low power factor) is in pretty much the same boat with the merchant since while he has motor and electrical capacity sufficient to produce twice as much output he is also handicapped by virtue of the inductive half of his power being side-tracked by reason of the energy wasted in wattless current which he pays for and does not get.

SEMI-TECHNICAL ANALOGY —MECHANICAL EXPLANATION

Inductive loads of power users create a condition of abnormal power factor by virtue of the inductance and the capacitances of the circuit being out of balance with each other. Where both conditions can be made to neatly balance each other one may hope to achieve a power factor rating that closely approaches the goal — 100% power factor. Since inductive loads are the usual type about all plants it is the commonly accepted practice to class all loads, other than the hoped for 100%, or unity, to be a staged percentage of the perfect. Let us assume we have a device, for instance an A. C. Welder, that is rated at 50% power factor. It must be grouped as being strictly in the class of the inductive load. In other instances, less numerous, the percentage figure quoted for the piece of equipment may be followed by the word "leading" which indicates the fact that it leads a 100% power factor by a certain percentage. Perhaps a mechanical analogy will make the picture more easily understood. Assume that a mechanic is engaged in hoisting a 50 lb. weight by means of a rope and a single sheaved block.

In this case all the energy he expends in pulling is directly conveyed to the weight by means of the rope and pulley. A second machanic is also lifting a 50 lb. weight but he has the use of balanced elevators.

In this instance the 50 lb. weight is aboard one elevator and the mechanic lifts it by pulling down on a line fastened to the floor of the upper car. The first mentioned installation has a 100% mechanical power factor rating while the second installation has a 50% power factor rating, that is, if each elevator weighs 50 lbs.

The second mechanic not only has to lift the 50 lb. weight but must of necessity also overcome the friction of the thrice loaded sheave,

an expenditure of energy that accomplishes nothing useful.

The two elevators, and the larger rope and sheave can all be considered as power lines and generators that are required to serve a plant with low power factor rating. These are capital investments that are not producing 100% because of the peculiarities inherent in alternating circuits and machinery. Direct current has no power factor problems and since it is but infrequently used we shall confine ourselves to A. C. and its peculiarities.

A. C. as we shall designate alternating current for purposes of brevity flows in surging waves from the generator to the load and back again. These surges flow in uniform even waves that rise and fall according to the number of poles in the generator and the speed it is driven. A. C. current is merely the rising and falling of an electromotive force over and under a zero line in a measured period of time. The term 60 cycles is indicative of the number of times the voltage wave has risen and receded for a period of one second in elapsed time. The usual count of cycles in A. C. is 60 times per second (60 cycles), but it may be 25 or some other number, especially in foreign countries. A cycle is usually considered to be the time element for one surge of current to travel from the generator to the load and return. Actually it is one positive surge plus one negative surge.

It passes through the zero line twice for each cycle of time, and this cannot occur without the time element.

In describing power factor we must consider that any electrical power must have two components —namely, voltage (potential) and amperes (the quantity of current flowing in any given movement) To understand power factor fully we must keep these two components constantly in mind for we shall deal with them in forthcoming discussions.

In an electrical circuit without load or one in which only non-inductive loads are present the amperes keep in step with the voltage and we have unity of 100% power factor, but when inductive equipment such as transformers, motors, solenoids and magnets are introduced into the circuit the ampere curve falls out of step with the voltage curve and we experience what is known as "lagging power factor." As an elementary explanation let us say that the amperes cannot take the turns of wire present in all inductive equipment with the same speed as the voltage. According to Ohm's law, as every electrical student knows, this cannot happen, yet it does and the explanation lies in the fact that Ohm's law cannot be applied in this instance except for an exact instance of time. Both volts and amperes MUST be calculated instantly and not voltage presently and amperes at a later instant in time.

From the above it is at once apparent that when the amperes lag behind the volts we cannot multiply them together for a true picture of watts consumed. To do so will give us volt-amperes and to obtain watts we multiply volt-amperes by the percentage of ampere lag to get the real value of watts.

As mentioned before, this percentage of watts is expressed as 50 per cent where watts equal one-half of the product of the line volts times line amperes. Actually the power factor value may vary broadly depending upon the type of equipment used in the electrical circuit. Expressed as formulae this is: Volts x Amperes x Power Factor equals Watts. In a circuit having no inductive loads power factor may be rated as 100% since volts and amperes are in phase we use this method: Volts x Amperes x 1 equals the same value as Volts x Amperes only, as stated in Ohm's law.

In this case the volts and amperes are in phase and the ampere demand will be high and in step with the high voltage points and will prove to be large in comparison with the actual consumption of amperes indicated by a lagging ampere curve. Expressed in other terms the situation is this: Where a low power factor of say 50% exists the line facilities must stand ready to supply a double demand of amperes to meet the load requirements on notice. These extra amperes perform no useful work but circulate to and fro on the line and are recognized as wattless current. While they perform no useful work they do require line and power station capacity over and above the immediate needs of the customer. This means the custimer is charged high rates to compensate the utility for the additional capital investment required and the customer himself must pay for the installation of needless copper in his plant.

CHECKING YOUR POWER REQUIREMENTS

Making a survey of your electrical load to make plans for correction of low power factor need not of necessity require the services of an engineer. Nor is it always imperative that one be consulted in the matter of enlarging the layout for increased production. Perhaps one can accomplish both in one survey and with a minimum of outlay for testing equipment. We need only review some of the quantities that require measuring, how best to go about measuring them, and what the values obtained mean in dollars and cents.

The ampere or quantity of current flowing is one of the paramount values we must consider in determining the carrying capacity of wires and cables. Heating of conductors is indicative of an overloaded condition that may easily result in the failure of either valuable equipment at a critical time or the continued loss of energy in attempting to transmit power over circuits containing insufficient copper or handicapped by poor power factor. Under conditions faced by industry today neither condition can be tolerated. Burnouts will occur at the most inopportune moment when production is upped to the best production record possible and when

repair materials are well nigh impossible of procurement.

Electrical currents are perhaps the easiest of all commodities to measure without cutting into the line to insert meters and thereby cause a partial or complete plant shutdown. In fact it is to the investigators advantage to have the full load on during his tests to better ascertain maximum loads. The modern tong or hook-on ammeter is the convenient means of checking loads on live equipment. These are current transformers provided with a split core to facilitate clamping them about a current carrying wire. The secondary winding of the unit is provided with a series of taps which may be coupled to the meter by means of a selector switch. One might assume, to see one of these devices in use, they might be inaccurate for the more minute calculatings required of fractional horsepower installations, etc. Such is not the case, however, since the instrument is accurate to a fault anywhere in the range from one to six-hundred amperes.

Lacking these new aids to the maintenance men one can make good use of existing equipment in the form of standard volt and ammeters. Perhaps the plant also has a current or potential transformer or two in the stock room which may readily be connected into a circuit under test during regular shutdown periods.

The ammeter is to the electrician what the clinical thermometer is to the physician. By its use he can determine the actual current flowing in a cable and by referring to a standard chart be informed of how seriously the line is overloaded. In checking the load on a circuit the ammeter tells the investigator of the load in amperes, yet he is uninformed on the percentage of voltage drop present at the end of the line and must therefore make use of the volt-meter.

Without proper voltage available motors will not function efficiently nor will lamps or heating units perform according to expected standards.

In this day of speeded up production and "round the clock" operation many circuits are seriously overloaded. In fact, the entire system in many cases is overloaded from the entrance switch on to the last outlet.

The apparent overloading of motors, which we shall touch on in later paragraphs, is in itself entailing some risk, but what is more serious is the fact that inadequate cable and wire sizes tend to cause undervoltage conditions that seriously decreases the efficiency and productive ability of vital machinery. In many cases the circuit layout is so envolved as to require opening of branch circuits and sub-feeders to arrive at the exact extent of the voltage drop and the connected load responsible therefore. And, in some instances the problem envolves a fluctuating load that causes wide variances in voltage during the working day.

For the latter condition a portable recording instrument is the required investment. By its use one is informed on just how varied and over what period of time the voltage drop prevails. Other volt meters of moderate cost that are merely instantaneous reading can be had and will suffice to make a host of tests since they are accurate to within ¾ of 1 percent of full scale. We have previously learned that the electrical twins, volts and amperes, are most effective when they act in the same direction at the same time. Power factor then being merely a means of measuring the effective co-operation between the amperes and the volts. When both are in step, ammeter and voltmeter readings indicate true watts.

THE WATT METER

Since that ideal is rarely reached we must look to an instrument that combines both the functions of the ammeter and voltmeter to give us an instantaneous reading of conditions in an A. C. circuit to give indications of balanced or unbalanced conditions on three phase service. Where higher than the conventional 220 or 440 volt lines are to be investigated, instrument transformers are required to step down high potential voltages and heavy ampere loads. The connections shown remain practically the same but the ratio of the several transformers employed must be used in the formulae to indicate actual primary power.

Connecting watts meters in this fashion proves that the power in any circuit is measured by the number of watt meter elements equal to one less than the total number of wires or lines in the circuit. With this method, unless abnormally large currents are envolved, unbalanced loads are of no consequence as long as they remain within the limitations of the instruments. Assuming that we have that rare condition of unity power factor and balanced load, the watt meter instrument will indicate readings that are both equal and positive. In all other instances, with loads of less than unity power factor, the indications will vary quite broadly in spite of the fact that the amperes flowing remain the same as in the circuit having unity power factor. This condition may lead to some rather puzzling problems since induction motors have the inherent peculiarity of drawing practically the same amperage when idling as when on load. This may cause one of the watt meters to give a zero reading. A condition that may be corrected by reversing the current connections to the zero reading instrument. Actual power will be then indicated. Of course, before any taps are disturbed the current should be shut off or the transformer secondary leads must be short circuited while the reversal is being made. Otherwise, the transformer is very apt to burn out quicker than a flash.

WATT METERS INDICATE POWER FACTOR

Reduce to its simplest terms power factor is the ratio between

the total watts in a circuit and the total volt-amperes. Or to express it in an equation:

Power Factor _____
_____

This method of calculating the power factor of an induction motor is quite accurate when employing two watt meters. The L and S being used to indicate these and for expedience in making it apparent that since they are but rarely alike, they are recognized as larger or smaller values. Where the readings are identical, as in the case where balanced loads prevail, the algebraic sum of the two reading divided by 1.73 times the line current and voltage potential between phases is the circuit power factor. Volt and ampere values may be disregarded when two single phase watt meters are connected with this provision, they must be balanced. In some rare instances one watt meter may read backward, which is an indication that the power factor is below the proverbial deadline of 50%.

Two short cuts are suggested for the engineer having numerous calculations to make. The first is the use of a graph calibrated to indicate percent power factor in the vertical left column, and the bottom margin is scaled in values ranging from 0 to 1.0. In practice the smaller reading is divided by the larger taken from two watt meters and locate the point for this value on the bottom scale. Then extend up vertically until the curve is reached and an extension to the left gives the power factor. The second method is the use of a power factor meter operating on the two-watt meter principal on polyphase balanced load circuits. This meter does automatically what ordinarily requires some long hand figuring.

WATTLESS CURRENT

Previously mentioned was the instance where power factor was indicated as being below 50%. This is possible where under loaded induction motors are numerous in a plant. Properly loaded motors usually are not considered as serious contributors to poor power factor conditions. Bad power factor conditions cost the plant owner much money that may not appear on the monthly power bill. Low voltage conditions cause hot wires, hot switches, and hot service lines continue to grow hotter as the drag on wattless current increases to ride the power circuits. One can easily be misled in making tests on motors to determine if the unit is properly loaded when using only an ammeter since as aforementioned the circuit requirements of a motor are pretty much the same when running light or fully loaded. The ammeter is of value in checking load conditions ere a burn out occurs, yet the only sure method lies in the use of watt meters to guard against the hazard of overload due to either low power factor or just plain overload. Voltage and current readings with ordinary instruments will aid the engineer in locating possible sources of trouble, still he must, if he is thorough, make use of watt meters to take really intelligent steps toward making permanent corrective measures possible.

CAPACITORS CORRECT REACTIVE K. V. A. ON POWER CIRCUITS

Surveys made by the larger companies indicated that the power factors of customers in all too many instances were in the neighborhood of 70% and in some cases hovered near the 50% mark. This makes it self evident that the reactive KVA ties up a large portion of the system capacity, from the motors in the plant all the way back to the generators in the hydro or steam plant, and is responsible for a large idle investment in power system facilities.

Assuming that we have a system rated as 70% power factor that delivers the same amount of reactive amperes for which we pay yet receive no benefit, as kilowatt amperes. Freeing ourselves of these reactive amperes cuts our power bill and increases the capacity of our system without having invested a dime for system enlargement.

Approximately 35% in generating and transformer capacity is made available for additional load. The line or copper losses of the system are reduced fully 40% and on all lines and feeders, where voltage drop had been a bugaboo, the increase in load capacity will improve to carry from 30% to 150% more kilowatt amperes.

There are several corrective measures to be applied to the problem, the outstanding ones being the installation of synchronous condensers and capacitors. At the outset the former is probably more of power company's medium than that of the customer since its first cost is relatively high and the principal function of the condenser is the correction of voltage drop on power lines; usually sub-transmission lines and distribution systems receive but few if any benefits from the investment. Small synchronous condensers are relatively rare for installation at the point of load for purposes of correcting reactive KVA.

Where lagging currents prevail with light loads, rather than leading currents, the condenser is best suited to improve voltage conditions.

SUB-STATION CAPACITORS

The service entrance is probably the ideal location for the installation of the capacitor since it usually is the point closest to the source of reactive K V A. However, where lines are extended over a large area by means of both enclosed and overhead circuits to various departments other locations may prove advantageous, such as prime mover motors, substation buses, and large distribution cabinets. Factors controlling the cost of capacitors per K V A are the voltage and K V A rating of the particular unit. Therefore, the equipment showing the maxi-

mum savings may not of necessity be the one guaranteeing the greatest overall return for the money invested.

At the present time, because of limitations, the type of capacitors that represent the lowest cost per K V A are those intended for service on 2300 and 4000 volt circuits. This in most instances confines the use of this class of units to main sub-stations or prime mover circuits employing at least 2300 K volts.

SECONDARY CAPACITORS

While this type of unit costs more than the primary type it has the advantage of being smaller and lighter in weight, therefore, can be installed in congested places near the source of reactive K V A. The value of the released system capacity can be calculated in the boosting of sagging voltages or the reduction in net K V A loading.

And since the limiting factor of transformer banks is their thermal capacity, the effectiveness of capacitors in increasing this capacity is the principal function by reducing net KVA demand. A typical installation consists of two 30 K V A, one 45 K V A, and one 22½ K V A capacitors mounted adjacent to the same number of feeder panels. All the feeder buses and the related equipment are connected in this manner to produce the utmost cumulative effect on fuses, switches and cables. The immediate effect of the installation of capacitors was the lowering of temperatures on the above mentioned equipment with the brightening of lights and the bringing of motors up to their rated speed and horsepower. The sum total of the effect on the service is 129¾ K V A and present meter readings show a fine reduction well in excess of 139 amperes on a demand of 125 KW. The power factor is usually a few points above 80.

NO SHUTDOWNS

The installation of capacitors at a neat saving over enlarged system facilities or rewiring costs is by no means the only saving. They are installed in practically all instances without a moment's interruption to production. Delays due to blown fuses and tripped overload devices are eliminated while motors start with their old time customary torque. Consult with your power company to learn if you need primary capacitors installed on the high potential side of your sub-station or if numerous secondary installations about the plant will best serve your purpose. You will find their representatives more than pleased to serve you.

The W. G. Duncan and Peabody Coal Co., of Greenville Ky., has just placed in service the largest electrically powered shovel built by the Bucyrus Erie Co., of South Milwaukee, Wis.

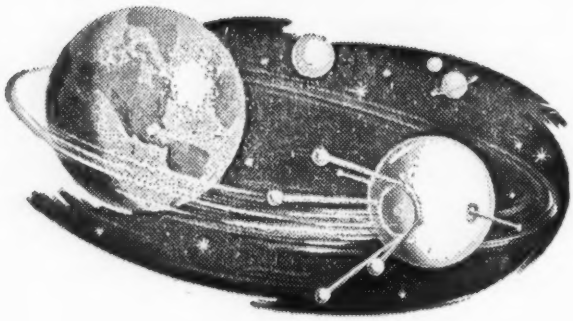
The giant is taller than a 13-story building, weighs 2,400 tons and is powered by 15 large direct current motors that force the 55-yard capacity dipper on it's 86 ft. long dipper sticks into the broken rock, lift it, swing it, and dump it; some 300 ft. away from the digging point.

The 80 ton load is raised high by virtue of a 145 ft. boom through which is reeved one-half mile of wire rope for the hoist and boom lines.

The "Queen" moves on four mighty "cats" and each corner of the massive frame is supported on a hydraulic jack that is self leveling by reason of a mercury switch controlling the oil pressure automatically in keeping with the terrain the shovel moves over.

The control cab is air conditioned and equipped with modern instrumentation that records the current and time required to complete a cycle-dig, swing, dump-dig.

The mahine is capable of moving 100,000 tons of overburden in 24 hours. The uncovering of the coal seam will produce some 2 million tons of coal per year with smaller shovels handling the coal digging.



Automation, More Precision On The Horizon

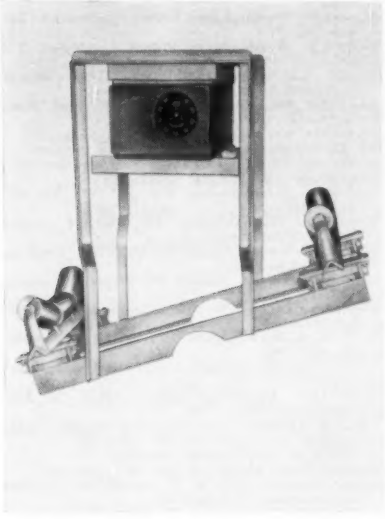
• By the year 1978, there will be unlimited power, under automatic control, unimaginable to the average man today.

Industry is undergoing important progress in automation with electronic technology as the vital key. Instruments used on a broad range of industrial products; neuclionic testers operating on high-frequency sound waves; electronic testers applying super sensitivity of vacuum tubes and transistors to industrial application; standard air, hydraulic and mechanical devices which take measurements and control processes; record data or trigger reactions and electronic computers promise to have a greater impact upon our society than atomic energy. In the next twenty years the electronic industry promises to surpass our present automotive industry in size.

Technologists say that magnetic recording suggests a potential for which there is no end in sight.

Automated production lines, having ultra sensitive controls, must have their parts inspected by highly sensitive devices. Up to now 1/1,000 of an inch fit in machinery was satisfactory. With precision instruments of today, machining is being done in the millionth of an inch. An instrument is today checking bearings and their parts to three millions of an inch.

• A new totalizing inventory belt scale that recalibrates linearly has been developed by the Thayer Scale Corporation. Scales with capacities of 100 lbs. to 300 tons per hour are available. Scale and rollers support level or inclined conveyor systems at any location. The endless belt is not altered or interrupted. Totalizer can be remotely located or read directly at the scale. Recalibration is claimed to be simple and exact; a known test weight is placed on the scale platform and a direct linear setting made



without the use of compensating chain or involved calculations. The Thayer Plate Leverage System is guaranteed accurate for the life of the scale. It is claimed that neither dust nor dirt, shock nor vibration can effect its high accuracy. Scales are now operating in systems conveying ores, chemicals and other materials. For further information, write Thayer Scale Corp., Thayer Park, Pembroke, Mass.

• An independent brake control group has recently been made available for the Caterpillar DW20 Tractor, according to a current announcement by Caterpillar Tractor Co.

Designed for use with either wagons or scrapers, the attachment allows the operator to engage the brakes of the trailed unit only. It works independently of the standard tractor brakes, and serves as an antijacknifing device when operating on hazardous underfooting.

The control group consists of a two-position hand operated air valve and air circuit, with the hand valve being mounted conveniently on the steering column.

The braking attachment is available for field installation, or may be factory-installed on new machines, when specified.

Screening plant and coal bins at Robert Coal Co. southeast of Gallup, New Mexico. A Caterpillar D8800 Diesel Electric Set furnishes power for operation of the screening plant. Producing 200 to 250 tons of bituminous coal daily.

JEFFREY

MATERIAL HANDLING AND PROCESSING EQUIPMENT

POWER TRANSMISSION MACHINERY

CRUSHERS PULVERIZERS

CONVEYORS

CHAINS AND SPROCKETS

ELEVATORS

NORTHEASTERN INCORPORATED

321 Cherry Ave., N. E.
Canton, O.

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Zanesville, O.

OLD TIME BARGAIN DAYS *are here again at . . .*

J. T. FISH'S

Largest selection of the latest type used mining machinery to be found anywhere and at lowest prices

WE OWN WHAT WE ADVERTISE!

JOY EQUIPMENT—REBUILT

4—Joy 8AE Super 14BU Loader, rebuilt.
3—Joy 14-BU Loaders, low pedestal, 7AE.
2—Joy 14-BU Loaders, medium pedestal, 7RBE.
1—Joy 14-BU Loader, high pedestal, 7BE.
2—Joy 12-BU Loaders, 9E, latest type.
1—Joy 12-BU Loader,, 220 volt AC.
1—Joy 20-BU Loader, latest type.
1—Joy 11-BU Loader, latest type.
2—Joy 8-BU Loaders, 250 volt DC.
1—Joy 8-BU Loader, 34" overall height.
2—Joy 8-BU Loaders, 220 volt AC.
1—Joy curved Bar Head, complete.
2—Reliance 38-J Motors, 10 H. P.
6—Reliance 24-J Motors, 7½ H.P.
4—Reliance 10-J Motors, 5 H. P.
20—9-J Motors, 4 H.P.
6—New Wheel Units for Joy 6 SC Shuttle Car.
1—Goodman 660 Loader on cats, excellent.
1—Goodman 665 loader on cats, latest type.
2—Joy 6 SC Shuttle Cars, rebuilt.
2—Joy 5 SC Shuttle Cars, rebuilt.
2—Joy 32E9 Shuttle Cars.
2—Joy 32E10 Shuttle Cars, rebuilt.
2—Joy 32E15 Shuttle Cars, rebuilt.
1—Joy 32E16 Shuttle Car, rebuilt.
2—Joy 42E16 Shuttle Cars, rebuilt.
1—Joy T-2-5 low pan Cat Truck.
1—Joy T-2-6 low pan Cat Truck with reel.
2—Joy T-1 Standard Cat Trucks, 220 AC.
1—Joy T-1 Standard Cat Truck, 250 DC.
2—Joy 11-B Cutting Machines, like new.
1—Joy 7-B Cutting Machine, like new.
3—Joy CD-22 Drills, like new.
6—Goodman 512 machines. with Bugdusters.
1—Goodman Machine on Cats, 31" high. All hydraulic.
1—Goodman 512 cutting machine, perfect.
2—Goodman 512 cutting machines, 220 volt A.C.
1—LeeNorse low vein Machine Carrier on rubber.
2—Jeffrey 70 URB's, rubber-tired Cutters, Universal head, perfect condition.
1—Joy 10 RU Rubber-tired Cutter, first class.
1—Joy 11RU, rubber-tired Cutter with bugdusters, Universal head, like new.
2—Jeffrey 29UC Cutting Machines, Universal head, cuts anywhere in seam, 38" high, on cats, 250 volt DC.

LOCOMOTIVES

3—Jeffrey 13 ton, type MH-110, 36", 42" and 44" Ga.
2—Jeffrey 10 ton, type MH-110, 42" and 44" Ga.
1—Jeffrey MH-124, 6 ton, 24" overall height.
12—Jeffrey, 6 ton, type MH-88, 42", 44" and 48" Ga.
2—Jeffrey, 8 ton, type MH-100, 2" armor plate frames.
1—Jeffrey, 6 ton, type 2186, 22" above rail.
3—Jeffrey, 4 ton, type MH-96, 42", 44" and 48" Ga.
1—G. E., 4 ton, type 825 Locomotive, 22" high.
10—G. E., 6 ton, types 801, 803, 821 Locomotives, 42", 44" and 48" Ga.
1—G. E., 8 ton, type 822 Locomotive, 44" Ga.
3—G. E., 10 ton, type 809 Locomotive, 42", 44" and 48" Ga.
2—Goodman, type 33, 6 ton, 44" and 48" Ga.
3—Goodman, 8 ton, type 32A, 36", 44" and 48" Ga.
3—Westinghouse, type 902, 4 ton, 42" and 48" Ga.
2—Westinghouse, type 904, 6 ton, 44" and 48" Ga.
2—Westinghouse, type 906, 44" and 48" Ga.
2—Westinghouse, type 907, 10 ton, 44" and 48" Ga.
2—Diesel Locomotives, 8 and 10 tons, Excellent.
8—Jeffrey MH-78 Locomotive Units, cheap.
3—Plymouth Diesel Locomotives, 8 and 10 tons, 42 in. and 44 in. Ga.

LOCOMOTIVES (Cont.)

4—Jeffrey MH-88 Locomotive Units, real bargains.
6—Jeffrey MH-100 Locomotive Units, reasonable.
Locomotive Trucks and Spare Armatures for all the above.

TIPPLE EQUIPMENT

1—Cedar Rapids portable super Screening Plant.
1—Allis Chalmers 5'x14' Rippflo Vibrator.
1—5'x14' Robins double deck Vibrator.
1—4'x10' Robins Gyrex Vibrator.
1—Roberts & Shaffer tandem Hydro-Separator. Belt Loading Boom.
1—Robins Car Shakeout.
10—Crushers, various sizes.
Feeders, Drag Conveyors and Loading Booms.

CUTTING MACHINES

1—Joy 10RU, rubber tired Cutter.
2—Jeffrey 70URB Cutters, rubber-tired, Universal Head, low vein.
3 Jeffrey 29UC Universal Machine on Cats.
1—Joy rubber-tired 11RU Cutter with bugdusters.
1—Goodman on Cats, 31" overall height.
3—Baby Goodman 212's, rebuilt, 250 volt DC.
1—Baby Goodman 212, rebuilt, 220 volt, 3 phase AC.
1—Goodman 312, 18" high.
6—Goodman 512's with Bugdosters, like new.
4—Goodman 512's, rebuilt, or as removed from service.
2—Joy 11B Cutting Machines, rebuilt.
2—Goodman 512 Cutting Machines, 220 volt A. C.
6—Goodman 12AA's and 112AA's.
2—Goodman 324 Slabbers.
2—Goodman 724 Slabbers.
6—Jeffrey 35L's, like new, 17" high.
2—Jeffrey 35L's, on low vein trucks.
1—Jeffrey 35L, 220 volt AC.
15—Jeffrey 35B's and 35BB's
2—Jeffrey 29B's on track.
2—Jeffrey 29C's track mounted.
1—Jeffrey 29L on track, perfect.
2—Sullivan CR-10's, 15" high.

LOADING MACHINES

16—Loaders, all types.
2—Jeffrey 61 CLR's on rubber, 26".
3—Jeffrey L-500 Loaders.
2—Myers Whaley No. 3 Automat Loaders.
2—Clarkson Loaders, 26" above rail.

CONVEYORS

1—Jeffrey 52-B, 30 in. Conveyor, 1,000 ft. Excellent.
Excellent.
4—Joy 30" Underground Belt Conveyors, 500' to 2000' each. Excellent.
1—Barber Greene 30" Belt Conveyor, 1000'. Excellent.
1—Robins 30" Belt Conveyor, 1000'.
1—Jeffrey 52-B, 26 in. Conveyor, 1200 ft. each.
3000' Conveyor Belt, 30".
2—61EW Elevating Conveyors
2—61WH 15" Room Conveyors, 300 ft.
2—Joy 15" Room Conveyors, 300'.
2—Joy 20" Conveyors, 300'.
4—Joy Ladel UN-17 Shakers.
10—Goodman G-12½ and G-15 Shakers.
3—Long 400 DBH 15" Chain Conveyors, 25 H.P. Motors, new.

CONVERTERS AND DIESEL PLANTS

1—50KW, G. E. TC-6, 275 volt Rotary Converter.
2—100KW, G. E. TCC-6's, 275 volt, Rotary Converters.
1—150KW, G. E. HCC-6, 275 volt, Rotary Converter.
1—150KW, 6 phase, Allis Chalmers Rotary Converter, 275 volt DC, perfect.
1—200KW Allis Chalmers, Rotary Converter 6 phase, 275 DC, perfect.

Converters and Diesel Plants (Cont.)

1—200KW, G. E. HCC-6 Rotary Converter, 275 volt DC.
1—300KW Portable Rectifier.
3—300KW, G. E. HCC-6 Rotary Converters, 275 DC.
3—300KW Westinghouse, 6 phase, Rotary Converters, 275 volt DC.
1—375KW Westinghouse Rotary Converter, 275 volt.
2—500KW Westinghouse Rotary Converters, 275 volt DC.
1—200KW Westinghouse Rotary Converter, 275 DC.
(all the above with 6900/13000 and/or 2300/4000 primary transformers)
2—150KW MG Sets, General Electric and Westinghouse.
1—200KW MG Set, Westinghouse, rebuilt.
1—200KW MG Set, General Electric, perfect.
2—150KW Allis Chalmers MG Sets, 275 DC volt, excellent. 220-440 AC volt.
1—300KW Westinghouse, 600 volt MG Set, rebuilt.
2—300KW Westinghouse, 600 volt, 6 phase, Rotary Converters.
4—500KW Westinghouse, 600 volt, DC, 6 phase, Rotary Converters.
1—500KW HCC-6 Rotary Converter, 6 phase, 600 volt DC.
1—Cummins 125 KW, Diesel with 250 volt DC Generator.
1—G. M. C. Diesel Plant with 60 KW Generator, 275 volt DC.
1—G. M. C. Diesel Plant with 85 KW Generator, 275 volt DC.
1—D-13,000 Caterpillar Diesel with 75 KW Generator, 275 volt DC.
1—Allis Chalmers Natural Gas Engine with 100KW Generator, 275 volt DC.
1—700 H. P. Shaft Hoist, complete.
Complete steam plant, will sell all or any part.
Boilers, like new, 1100 H. P. and 500 H. P. Also transformers, turbines, etc.
1—Complete Tipple with Cleaning Plants.

MISCELLANEOUS

4—All Steel Armco Buildings, various sizes.
20—Jeffrey Molveyors on rubber tires.
1—¾ Yard Shovel and Back Hoe.
1—¾ Yard Crane on Cats.
Battery Supply Tractors, rubber tired.
1—Cantrell Air Compressor on rubber tires.
10—Air Compressors, 1 H.P. to 40 H.P.
40 Mine Pumps, all types.
1—Differential 40 Passenger Man-Trip Car.
6—MSA Rock Dusters.
2—Phillips Carriers, 44" and 48" Ga.
2—Barber Greene self propelled Bucket Elevators.
Pipe, Plastic, Steel, Transit, all sizes 1" to 6".
45 Mine Cars, drop bottom, 42" Ga.
30 Mine Cars, drop bottom, 44" Ga.
100 Mine Cars, 18" high, end dump, 44" Ga.
100 Mine Cars,end dump and drop bottom, 20" high, 48" Ga.
1—10 ton Mine Car Scale with Recorder.
1—150 ton Railroad Track Scale.
15—Brown Fayro HKL and HG Car Spotters.
1—12 ton Differential Slate Larry.
Incline Hoists, 25 to 50 H. P.
1—Jeffrey 6' Aerodyne Fan.
1—Jeffrey 8' Aerodyne Fan.
1—Storage Tank, 8,000 Gallon.
2—Storage Tanks, 4,000 Gallon.
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● A pneumatic engine that does everything faster and better has been invented. With it has also come a double pneumatic engine that is described as the first ever reported developed.

Both are the inventions of Bernard A. Swanson of Sacramento, Calif., who earned one of the 830 patents to be awarded by the Government recently.

Mr. Swanson's engines are designed to be operated by compressed air or other motive fluid and can be used as pneumatic hammers, pneumatic vibrators, pile drivers and pull mechanisms. He claims that their invention and discovery provides pneumatic engines that can perform work "which cannot be done by presently used devices."

Generally, the engines provide greater efficiency, require less maintenance, are quieter and take a good share of the shock away from the operator.

Specifically, Mr. Swanson says, the engines can be used as vibrators for flour and powder; separators for sand and gravel; settling and tamping concrete; in reciprocatory equipment such as sickles and cutters for harvesters, sanders, rubbers and shears; fruit or nut tree shakers; hammering, chiseling, riveting, chipping or scaling; tree pruners; and for pile driving and excavating.

Both the single and double engines are further designed to allow control of their operational speed so they can perform different jobs, and allow control of the length of stroke.

Mr. Swanson, who received patent No. 2,821,962, accomplished his many purposes with a new relationship of porting, or the relationship of the inlet port to the exhaust ports.

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150-B Bucyrus Erie 6 yd. Elec. Shovel.
4500 Manitowoc 5 yd. H. L. Shovel.
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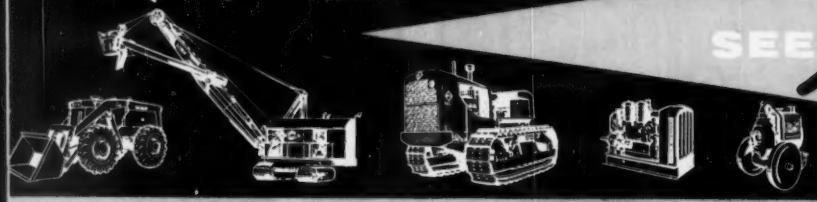

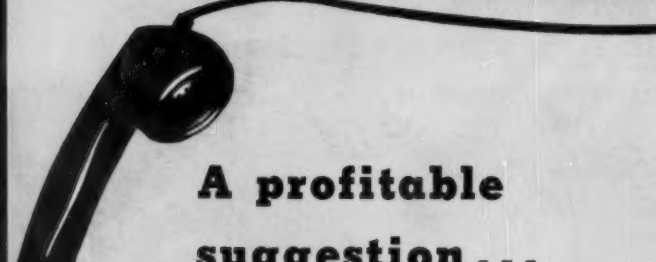

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